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## (54) IMPROVEMENTS IN OR RELATING TO MANDRELS

- (71) We, IMPERIAL METAL INDUSTRIES (KYNOCHE) LIMITED, a British Company, of Kynoch Works, Witton, Birmingham B6 7BA, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- This invention relates to a mandrel for use in manufacturing articles by wrapping a windable material around the mandrel, fixing the turns of the windable material to one another, and subsequently removing the mandrel. The windable material is typically glass, carbon, nylon or other filament, although strip material may also be appropriate, for example of high tensile strength steel. The turns of windable material are normally fixed to one another by a matrix material, typically a resin.
- The external surface of such a mandrel defines the interior shape of the article wound thereon, such that mandrels frequently need to have complex shapes. In addition, the mandrel must be capable of being extracted from the interior of the article, and preferably be inexpensive or readily re-usable.
- The invention provides a mandrel for producing an article by winding a windable material comprising support means, by which the mandrel can be mounted in a winding machine, said support means carrying a flexible, impermeable bag which has been filled with particulate material to conform to the shape of a mould cavity and then evacuated to form a rigid mandrel. The invention also provides a method of producing an article comprising winding material on such a mandrel.
- The flexible impermeable bag may be placed in the mould cavity either already filled with said particulate material, or empty, in which case the bag is filled with the particulate material whilst in the mould cavity.
- The mandrel may be produced by locating the flexible, impermeable bag in a mould cavity, before or after filling the bag with particulate material, moulding the bag to the shape of the mould cavity evacuating air from the bag and removing the rigid bag from the mould cavity to be used as the mandrel.
- Preferably the filling of the bag is accompanied by vibration to obtain good filling with the particulate material.
- Preferably also the bag is provided with axially extending spigots for use in mounting the mandrel when winding articles thereon. Preferably further said spigots are provided by a shaft extending through the bag. The shaft may be tubular and utilised for evacuating air from the interior of the filled bag.
- In accordance with the present invention also, a method of manufacturing an article comprises locating a mandrel as defined above in supports therefor, applying a windable material around the mandrel, fixing the turns of the windable material to one another, and subsequently removing the mandrel by admitting air to the bag, opening the bag, removing the rigid particulate material from the bag, and removing the bag from within the article.
- The invention further provides an article manufactured by the manufacturing method defined above.
- In use the mandrel is mounted in winding apparatus and used as a mandrel by having wrapped thereon the windings of the requisite windable material. Thus, for example, glass or carbon fibre is wrapped onto the exterior of the mandrel until the requisite number of layers has been produced. The fibre can be impregnated with resin before or during wrapping. The resin is then cured, for example in a curing oven. The vacuum in the bag is then released whereby the particulate material can be poured therefrom. The bag can be collapsed and subsequently removed from the interior of the cured article, or it can be left in position as a liner for the cured article.
- Reference will now be made to the sole

accompanying drawing which is a diagrammatic section of a mould with a mandrel therein, the mandrel being in the process of being filled and evacuated.

Thus referring to the drawing, this shows a mould 1 having a mould cavity 2 therein, of which the shape conforms to the shape of the requisite mandrel. The mould 1 can be of expanded polystyrene, glass-reinforced resin, or other plastics material. The mould cavity is partly defined by inserts 3 at each end. The inserts will form end fittings in the article to be wound on the mandrel.

The insert 3 at the end 4 of the mould has a collar 5 screwed therein, the collar having a co-axial aperture 6 through which passes a tubular shaft 7. The collar 5 may be fixed on the shaft 7 by means such as a grub screw (not shown). The lower end of the shaft 7 is fixed to a manifold 8 which is provided with a connection 9 for coupling with associated pressure and evacuation systems (not shown), and a shut-off valve 10 which can seal the interior of the shaft 7.

The shaft 7 is provided with a row of holes 11 along its length within the mould cavity 2, and is covered with a sleeve of gauze material 12 in that region. The shaft 7 carries a mandrel bag 13 which fits or can be expanded to fit the mould cavity 2. One end of the bag 13 grips the shaft 7 within the collar 5, and is held there by a clamp (not shown).

The shaft 7 extends from the collar 5 along the longitudinal axis of the mould cavity to the end 14 of the mould, and is there received by a temporary ring 15 screwed into the insert 3 at the upper end 11 of the mould 1. A funnel 16 with a circular array of delivery holes 17 is a sliding fit on the shaft 7 and traps the neck of the other end 18 of the bag 13 against the ring 15. The ring 15 and funnel 16 are shown in the drawing above the axis of the mould.

When the apparatus has been arranged in the way shown in the drawing, and thus far described, a pourable rigid strong particulate material is fed from the funnel 16 into the interior of the bag 13. A typical material is builder's sand, although other materials can be used, for example pulverised fuel ash spheres, or phenolic spheres. The mould 1 is preferably vibrated during this operation to pack the particulate material as tightly as possible into the bag. In addition, for example, from time to time during the filling operation, the manifold 8 can be utilised to blow air into the bag 13, to assist in packing and ensure that the bag presses against the wall of the mould cavity 2.

When the bag is full of sand or other particulate material, the ring 15 and funnel 16 are removed therefrom and the bag is closed by an annular bush 19 being fitted

over the shaft 7 and sealing between the shaft and the neck of the bag 13, and the insertion of a collar 20 similar to the collar 5 screwed into the insert 3. The bush 19 and collar 20 are shown in the drawing below the axis of the mould. Air is then evacuated from the interior of the bag through the connection 9 in the manifold 8, the valve 10 is closed, and the mandrel is removed from the mould 1.

The partial vacuum which exists within the bag will cause its external surface to be pressed inwardly under atmospheric pressure. The strong and rigid particulate material will resist this such that the mandrel will be rigid and resistant to deformation under its own weight or under the pressures exerted thereon during the winding and curing operations.

As mentioned above, when curing of an article wound thereon has been completed, the manifold 8 can be used to release the vacuum within the bag, the plug can be removed therefrom to enable the sand or other particulate material to be poured out, and the shaft and bag can be retracted from the manufactured article.

If required, the bag 13 may be provided with the correct quantity of particulate material before being placed in the mould 4. In this case closing of the mould halves onto the bag 13 is accompanied by vibration to shape the bag to the mould.

In a modification the shaft 7 is used to convey sand as well as to apply air pressure or vacuum. Thus both ends of the bag 13 are the same as the end at the collar 5, the gauze 12 is omitted, and the manifold 8 also incorporates an inlet for sand from a sand reservoir. In this modification the bag 13 is first inflated in the mould by air pressure, and then sand is allowed to pass or is pumped along the shaft 7 and through the holes 11 to fill the bag and the shaft. Vibration and/or air pressure can be used if necessary to provide complete filling. The sand supply is then stopped, and vacuum applied as before.

In a further modification the inserts 3 can be either omitted completely, or mounted on the completed article.

The degree of vacuum needed is not high, and with good sealing of the bag a pressure of 20 to 40 torr has been found to be satisfactory. A pvc/nitrile rubber compound is suitable for the bag 13. This has good temperature resistance (100°C continuous or 130°C for up to 10 hours), good abrasion and tear resistance and excellent resistance to atmospheric oxidation.

#### WHAT WE CLAIM IS:—

1. A mandrel for producing an article by winding comprising support means, by

which the mandrel can be mounted in a winding machine, said support means carrying a flexible, impermeable bag, which has been filled with particulate material to conform to the shape of a mould cavity and then evacuated to form a rigid mandrel.

2. A mandrel according to Claim 1 wherein the support means comprises axially extending spigots.

10 3. A mandrel according to Claim 2 wherein said spigots are provided by a shaft extending through the bag.

15 4. A mandrel according to Claim 3 wherein the shaft is tubular and can be utilised for evacuating air from the interior of the filled bag.

20 5. A mandrel for producing an article by winding substantially as herein described and with reference to the accompanying drawing.

6. A method of producing an article

comprising winding material on a mandrel as claimed in any of Claims 1 to 5.

7. A method of manufacturing an article comprising locating a mandrel as claimed 25 therefor, applying a windable material around the mandrel, fixing the turns of the windable material to one another, and subsequently removing the mandrel by admitting 30 air to the bag, opening the bag, removing the particulate material from the bag, and removing the bag from within the article.

8. A method as claimed in Claim 7 35 wherein the windings are fixed to one another by a matrix resin.

9. An article manufactured by the method claimed in Claim 7 or Claim 8.

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